CLAIMS

1. A remote tire monitor system comprising:

a control unit; and

a plurality of tire monitors mountable on respective wheels of a vehicle to transmit radio signals to the control unit, the respective tire monitors each including

a pair of sensors to produce first and second sensor signals which are proportional to a change in force applied to the sensors, and

a control circuit configured to determine position information for the respective tire monitor based on the first and second sensor signals from the pair of sensors.

2. The remote tire monitor system of claim 1 wherein the pair of sensors comprises:

a first piezoelectric sensor mounted to produce the first sensor signal in response to a change in force applied along a first axis; and

a second piezoelectric sensor mounted to produce the second sensor signal in response to a change in force applied along a second axis.

3. The remote tire monitor system of claim 1 wherein the pair of sensors comprises:

first and second piezoceramic sensors.

4. The remote tire monitor system of claim 1 further comprising:

a received signal strength indication (RSSI) circuit to determine relative strength of transmitted radio signals from tire monitors received at the control unit.

5. The remote tire monitor system of claim 4 wherein the transmitted radio signals include the position information.

6. The remote tire monitor system of claim 5 wherein the control unit is configured to determine respective positions of the plurality of tire monitors on the vehicle in response to the position information in the radio signals transmitted by respective tire monitors and the relative signal strength of the transmitted radio signals.

7. The remote tire monitor system of claim 6 wherein the transmitted radio signals include right side – left side position information determined at the respective tire monitors in response to the first and second sensor signals and wherein the control unit determines forward – rear position information for the respective tire monitors based on the relative signal strength of the transmitted radio signals.

8. The remote tire monitor system of claim 4 wherein the transmitted radio signals include temperature information and wherein the control circuit operates in response to compensation software, the control circuit in conjunction with the compensation software configured to compensate the relative strength of the transmitted radio signals using the temperature information.

9. A tire monitor configured for mounting on a vehicle, the tire monitor comprising:

a first shock sensor to produce a first motion signal;

a second shock sensor to produce a second motion signal; and

a circuit coupled to the first shock sensor and the second shock to determine right side – left side position information for the tire monitor based on the first motion signal and the second motion signal.

10. The tire monitor of claim 9 wherein the control circuit is configured to determine the right side – left side position information for the tire monitor based on a lag – lead relationship of the first motion signal and the second motion signal.

11. The tire monitor of claim 9 wherein the circuit is configured to alternately sample the first motion signal and the second motion signal.

12. The tire monitor of claim 9 further comprising:

a tire condition sensor to produce a tire condition signal; and

a radio circuit coupled to the control circuit to transmit radio signals based at least in part on the tire condition signal.

13. A tire monitor method comprising:

detecting state of a motion detection signal in a tire monitor mountable on a wheel of a vehicle;

based on the state of the motion detection signal, determining if the tire monitor is moving;

if the tire monitor is moving, determining a lag – lead relationship between two motion detection signals; and

based on the lag – lead relationship, estimating position information for the tire monitor.

14. The method of claim 13 wherein estimating position information comprises estimating wheel rotation direction for the tire monitor.

15. The method of claim 13 wherein estimating position information comprises estimating right side – left side position of the tire monitor on the vehicle.

16. The method of claim 13 wherein determining the lag – lead relationship comprises:

evaluating the period of a first motion detection signal;

timing a delay from a point of the first motion detection signal to approximately the same point of a second motion detection signal; and

if the delay is less than one-half the period, determining the second motion detection signal leads the first motion detection signal.

17. The method of claim 13 further comprising:

determining the lag – lead relationship a predetermined number of times;

incrementing a counter of a plurality of direction counters based on the determined lag – lead relationship; and

based on values of the plurality of direction counters, estimating the position information.

18. The method of claim 17 further comprising:

transmitting an indication of the estimated position information.

19. The method of claim 18 further comprising:

transmitting data defining degree of confidence in the position information.

20 The method of claim 19 wherein transmitting data defining degree of confidence comprises transmitting contents of the plurality of direction counters.

21 The method of claim 19 wherein transmitting data defining degree of confidence comprises transmitting data encoding the estimated position information and data defining the degree of confidence.

22. A method for determining position information for respective tire monitors in a remote tire monitor system including a control unit, the method comprising:

monitoring radio frequency data transmitted by the respective tire monitors and received at a receiver, the radio frequency data including right side – left side position information determined at a transmitting respective tire monitor using first and second shock sensors which produce motion signals in response to motion of the transmitting respective tire monitor;

when a number of data transmissions exceeds a threshold, assigning left hand side positions and right hand side positions for the respective tire monitors based on the right side – left side position information contained in the radio frequency data from the respective tire monitors;

assigning front and rear positions for the respective tire monitors; and

storing new tire monitor positions at the control unit.

23. The method of claim 22 wherein monitoring radio frequency data comprises:

detecting a data frame transmitted by a respective tire monitor, including

decoding data contained in the data frame, and

determining a received signal strength indication (RSSI) for the data frame;

determining the right side – left side position information from the decoded data; and

updating a rotation direction counter for the respective tire monitor.

24. The method of claim 23 wherein monitoring radio frequency data further comprises:

determining a function code for the data frame from the decoded data;

identifying rotation direction information from the decoded data; and

if the function code is associated with a stationary condition or an activation condition of the respective tire monitor, updating stored tire condition information for the tire monitor with tire condition information from the decoded data.

25. The method of claim 23 wherein monitoring radio frequency data further comprises:

after updating the rotation direction counter, updating stored tire condition information for the tire monitor with tire condition information from the decoded data.

26. The method of claim 22 wherein assigning left hand side positions and right hand side positions for the respective tire monitors comprises:

determining from the right side – left side position information for the respective tire monitors whether two left side and two right side tire monitors have been detected; and

if so, allocating the left side tire monitors to the left hand side positions and allocating the right hand side tire monitors to the right hand side positions.

27. The method of claim 26 wherein assigning left hand side positions and right hand side positions for the respective tire monitors comprises:

determining from the right side – left side position information for the respective tire monitors whether two same side tire monitors and one other side tire monitor and one unknown tire monitor have been detected;

if so, allocating the one unknown tire monitor to the same side as the one other side tire monitor;

determining whether two left side and two right side tire monitors have been detected; and

if so, allocating the left side tire monitors to the left hand side positions and allocating the right hand side tire monitors to the right hand side positions.

28. The method of claim 22 wherein assigning front and rear positions for the respective tire monitors comprises:

retrieving stored received signal strength indication (RSSI) information for the respective tire monitors;

for tire monitors assigned to left hand side positions and right hand side positions, identifying two same side tire monitors having RSSI information in a predetermined range;

identifying one tire monitor of the two same side tire monitors having greater RSSI values;

determining a front or rear location on the vehicle for the receiver;

allocating the one tire monitor of the two same side tire monitors to a front or rear position based on the front or rear location for the receiver; and

allocating the other tire monitor of the two same side tire monitors to the other of the front or rear position.

29. The method of claim 28 further comprising:

detecting temperature data for a transmitting tire monitor in the monitored radio frequency data;

measuring an RSSI value for the monitored radio frequency data;

compensating the RSSI value according to the detected temperature data and storing the compensated RSSI information.

30. A method in a receiver of a tire monitor system, the method comprising:

receiving radio transmissions from tire sensors of the tire monitor system;

determining received signal strength indication (RSSI) values for the received radio transmissions;

decoding the radio transmissions to determine tire temperature information; and

compensating the RSSI values according to the tire temperature information to reduce variance in the RSSI values.

31. A tire monitor method comprising:

detecting state of a motion detection signal in a tire monitor mountable on a wheel of a vehicle;

based on the state of the motion detection signal, determining if the tire monitor is moving;

if the tire monitor is moving, determining a lag – lead relationship between two motion detection signals;

based on the lag – lead relationship, deciding if the tire monitor is mounted on a right hand side position or a left hand side position on the vehicle;

based on the decision, incrementing a right hand counter which stores a right hand counter value or a left hand counter which stores a left hand counter value;

transmitting to a remote control unit information about the decided right hand side position or left hand side position; and

transmitting to the remote control unit information about confidence in the decision.

32. The method of claim 31 further comprising:

encoding the information about the decided right hand side position or left hand side position and the information about confidence in the decision; and

transmitting the encoded information.

33. A tire monitor method comprising:

detecting an acceleration signal in a tire monitor mountable on a wheel of a vehicle;

based on period of the acceleration signal, estimating rotation period of the wheel;

transmitting to a remote control unit of the vehicle information about the estimated rotation period; and

correlating data based on the estimated rotation period with vehicle speed data.

34. The tire monitor method of claim 33 further comprising:

based on the correlation, concluding at the control unit that the tire monitor is mounted on the vehicle.